C3 end

means to disable said laser diode if predetermined product values of pulse magnitude and pulse duration are exceeded.

Remarks:

In the Office Action dated January 20, 2003, the Examiner stated that the oath/declaration was defective because it did not identify the citizenship and mailing address of the inventor. Please find included herewith a completed, signed Declaration identifying the citizenship and mailing address of the inventor in effect at the time of filing of the original oath/declaration, and presently in effect.

The Examiner also indicated in the most recent Office Action that the substitute drawings filed on October 31, 2002, have been approved. Accordingly, please find included herewith a set of drawings conforming to the changes approved by the Examiner.

Rejections Under 35 USC §112

Claim 8 stands rejected as indefinite under §112, second paragraph. In particular, the Examiner states that there is insufficient antecedent basis for the limitation "said host microprocessor" in line 7. This rejection is traversed, for the reason that the subject microprocessor is originally introduced as a host microprocessor in line 4 of the claim. For clarity, the subject portions of claim 8 are reproduced below, with the relevant limitations in bold type:

8. A laser driver control system comprising:
a remote microprocessor;
a laser driver printed control board;
a host microprocessor on said printed control board;
at least one laser driver and a corresponding laser diode on said printed control board; and
a serial communication between **said host microprocessor**...

Rejections Under 35 USC §102

Claim 1 stands rejected under 102(e) as being anticipated by Pfaff (US 6,292,498). Applicant notes a filing date for Pfaff of May 21, 1999. The effective date of Pfaff is after the date of reduction to practice of the claimed invention, and Pfaff

therefore does not qualify as prior art. Applicant has included herewith an additional Declaration, wherein the inventor states the following:

> I conceived of the claimed invention in the State of Michigan sometime in the Fall of 1998 and I constructed a working prototype prior to about January 11, 1999.

Thus, Applicant conceived and reduced to practice an embodiment of the invention of claim 1 prior to the effective date of Pfaff, and the rejection under 102(e) is overcome. Applicant therefore respectfully requests withdrawal of the same.

Claim 12 stands rejected under §102(b) as anticipated by Sprague et al. (US 5,138,340). Applicant has amended claim 12 to further require the step of:

> operating temperature control means to maintain an output wavelength of said laser diode within a predetermined range during diode operation

Sprague does not teach all the limitations of amended claim 12, and the rejection is therefore overcome. In fact, rather than controlling the temperature of the diode to keep the laser output wavelength within a particular range, Sprague does just the opposite. Sprague is directed to a system wherein the current levels to the diode are adjusted for the express purpose of adjusting the temperature of the diode, thereby adjusting laser output wavelength (Abstract). In contrast, Applicant's device is contemplated for use with applications wherein temperature fluctuations are minimized. In Applicant's specification, at page 3, lines 17-18, it is stated: [The host computer] "maintain[s] the temperature of the laser diode within one degree or less accuracy to a temperature set-point." Further, Applicant identifies temperature/wavelength fluctuation as a specific problem in earlier designs at page 1, lines 16-18: "A related problem has been accurate temperature control of the laser diode, as minor temperature changes will affect the wave length of the laser beam generated by the laser diode". Thus, Sprague does not teach all the limitations of claim 12. Moreover, because Sprague is contemplated for use in a significantly different type of system/process than Applicant's invention, no convincing case for obviousness of the invention of claim 12 in view of Sprague can be made. The Sprague system utilizes temperature change to adjust the laser output wavelength, whereas Applicant's design seeks to *minimize* wavelength fluctuation by minimizing temperature change. The two designs are thus fundamentally different in their operating

principles. Accordingly, the rejection to claim 12 is overcome, and Applicant respectfully requests withdrawal of the same.

Claim 14 stands rejected under §102(b) as being anticipated by Rudd (US 5,821,527). The rejection is traversed for the reason that Rudd does not disclose the features of claim 14 stated by the Examiner to be "inherent." Therefore, Rudd does not teach all the limitations of claim 14, and the rejection is overcome. In particular, the Examiner states that Rudd discloses a P-channel MOSFET that allows "the pre-selected input power polarity to pass and turns off if the opposite polarity is received." To the contrary, Rudd discloses a P-channel MOSFET that <u>will not</u> turn off if the opposite polarity is received, and would thus be poorly suited to applications contemplated for the invention of claim 14, namely, systems protecting against overpowering of a laser diode. Rudd illustrates in Figure 12 (and the Abstract), a laser driver utilizing a P-channel MOSFET 74. Although the MOSFET body diode is not shown in Rudd, it is well known in the art that engineers commonly (if not nearly always) omit the body terminal or body diode in drawings of a MOSFET. *See, e.g. THE ART OF ELECTRONICS*, 2nd Edition, Horowitz and Hill, 1989, p.118: "It is common to see the body terminal omitted." In a conventional MOSFET design, like Rudd, the body diode has its cathode connected to the source and its anode connected to the drain. This differs from Applicant's design. Moreover, using a MOSFET having such a body diode would not provide a system with all the limitations of claim 14, nor all of the advantages of the invention contemplated by claim 14.

During normal operation, a conventional body diode such as that used in Rudd is reverse biased. However, if the power supply polarity is reversed, the diode will be forward biased. The body diode of Rudd would thus become turned on/conducting when the polarity of the power supply is reversed, and allow current to flow in reverse polarity through the laser diode. When the reverse polarity voltage applied to the laser diode is above the maximum allowed, usually around 2V to 3V, the laser will likely be permanently damaged. Because the power supply voltage is typically greater than the maximum allowable reverse voltage, there is a very real risk of permanent damage to the laser diode.

In contrast to Rudd and other conventional MOSFET designs, in Applicant's invention of claim 14, the body diode of the MOSFET has its anode connected to the drain and cathode connected to the source. This construction is depicted in Figure 5. When the polarity of the power supply is reversed, the body diode will be reverse biased and the MOSFET will be turned off since its gate voltage will be the same as the source voltage. The laser is thereby protected because it cannot receive the reverse voltage. This characteristic of the design corresponds to the claim limitations of claim 14, wherein the P-channel MOSFET is "connected to the power input of said circuit which allows the pre-selected input power to pass and which turns off if an opposite input power polarity is received." Rudd therefore does not teach all the limitations of the present invention, the rejection is overcome, and Applicant respectfully requests withdrawal of the same.

Rejections Under 35 USC §103

Claims 2-7 and 13 stand rejected under §103 as unpatentable over Freitag et al. (US 5,999,549) in view of Jabr (US 5,594,748), and further in view of Noda (US 6,229,833). Applicant has amended claim 2 to recite limitations not taught or suggested by the cited references, and the rejections are therefore overcome. Amended claim 2 requires storing in the microprocessor the safety parameters of laser pulse peak output power and laser pulse duration. These limitations are similar to limitations originally set forth in claim 4. Claim 2 also requires the step of "continuously monitoring laser pulse duration." The cited references do not teach steps wherein the parameters required by claim 2 are measured, either alone or in combination, and the rejections are therefore overcome.

Claim 2 requires "continuously monitoring" the laser output power, whereas Freitag only considers the output power when it exceeds a threshold. It does not matter in Frietag by what amount the threshold is exceeded. In Freitag, the laser may be disabled upon the occurrence of a relatively large regulator voltage (a threshold) during the sampling window, a situation that can cause overpowering of the laser (Freitag specification, column 3). In the most recent Office Action, of January 30, 2003, the Examiner states that Freitag discloses that the safety parameters may be output power and pulse duration. At column 3, lines 27-32 of Freitag, it is stated:

> The laser 214 would emit this high power until the fault detection 230 shuts the laser down. The duration of this high power pulse is defined by a timing capacitor 232. The duration of this pulse, coupled with the frequency of the LASER RESET signal can cause an unsafe laser optical power.

Freitag is concerned with overpowering of the laser, however, nowhere in the Freitag disclosure is actual *monitoring* of the pulse duration disclosed, much less continuous monitoring. Freitag operates by generating a LASER FAULT signal when a window detector detects if "the + terminal of the DC op amp B1 goes above 1.65V or below 1.35V" (spec. column 3, lines 8-9). If two successive faults are counted without an intervening safe condition, then the laser may be shut down. A timing capacitor 232 determines the time period within which these conditions must occur. In contrast, Applicant's invention of claim 2 continuously monitors (i.e. in real time) the output power and the pulse duration. If an excessive output power, pulse duration or product of pulse duration and output power is detected, then the laser will be disabled. A relatively complex design like Freitag's, requiring the timing capacitor 232 and the laser fault counter 202, is unnecessary in Applicant's design, which utilizes <u>continuous</u> monitoring of the parameters. Moreover, by considering both output power and pulse duration, Applicant's design monitors the total wear on the laser diode. This is a measurement of actual, calculated output, in contrast to Freitag, which measures only the presence or absence of fault conditions, and does not measure the magnitude of the conditions. A pulse <u>greatly</u> exceeding the power threshold and nearly equaling the duration threshold would not turn off the laser in Frietag. However, two peaks just exceeding the power threshold within the given time frame would cause a shutdown.

Similar to Freitag, Noda does <u>not</u> teach continuously monitoring the pulse duration, and would therefore be poorly suited for many of the applications contemplated for Applicant's invention of claim 2. Because neither Noda nor Freitag teaches continuous monitoring, the system could not be disabled based upon a product value of pulse duration and output power, even if combined with a microprocessor storing information, as taught in Jabr. Therefore, the proposed combination does not teach all the limitations of claim 2, and the rejection is overcome. Likewise, because claims 3-7

depend from claim 2, the rejections to those claims are also overcome, and withdrawal of the same is respectfully requested.

Claim 4 depends from claim 2, and the rejections are therefore overcome for reasons already expressed. However, claim 4 also requires: "said parameters include laser pulse duration and laser pulse peak output power <u>during pulsed mode laser operation</u>." Regarding claim 4, the Examiner argues with respect to Freitag that, "Even if Freitag is measuring the abnormal pulse, i.e. the fault condition, as asserted by the applicant, the fact there is a pulse shows that the laser is running in pulse mode." The "pulse" referred to by the Examiner does not indicate that Freitag is running in pulse mode at all. At column 3, lines 25-29, of the Freitag disclosure the definition of "pulse" as contemplated in the Freitag device is explained: "Assume a fault is caused by high optical power out of the laser. The laser 214 would emit this high power until the fault detection 230 shuts the laser down. The duration of this <u>high power pulse</u> is defined by a timing capacitor 232 in FIG. 2." The fact that the overpowering is a "pulse" of excessive power does not mean that the laser is running in pulse mode. Rather than indicating that Freitag is operating in a pulse mode, the specification indicates that the "pulses" are the periods during which the laser is unintentionally overpowered, a situation that may take place during continuous wave operation. Because Freitag uses a window comparator 224, if the laser were operated in pulse mode, even if it were not outputting an *average* power that exceeded the safety limit, a pulse above the threshold that fell within the window measured by the comparator could trigger a false alarm. In Frietag, the timing capacitor can allow measuring of the average *time* of overpowering, but it does not allow measuring of the average *power*. However, because the invention of claim 4 continuously measures both pulse duration and output power, in pulsed mode, the method allows computation of the average power, regardless of whether the laser operates in pulse or continuous wave mode. Therefore, the invention of claim 4 is not only literally distinct from the teachings of the cited references; it offers significant advantages over the designs disclosed therein. Because the suggested combination does not teach or suggest all the limitations of claim 4, the rejection to claim 4 is overcome.

Claim 13 also stands rejected as unpatentable over Freitag in view of Noda and Jabr. Claim 13 is not anticipated by the proposed combination of references for reasons similar to those expressed with regard to claims 2-7. In particular, claim 13 requires:

> a remote computer monitoring <u>the pulse frequency and duration</u> of said laser diode and means to disable said laser diode if predetermined pulse and duration values are exceeded; and
>
> means to disable said laser diode if predetermined <u>product values of pulse magnitude and pulse duration</u> are exceeded. (emphasis added)

The proposed combination of references does not teach monitoring both the pulse frequency and duration, and therefore does not set forth a prima facie case of obviousness. However, Applicant has amended claim 13 to clarify the distinctions over the cited references. Specifically, claim 13 requires means for disabling the diode if the product of pulse magnitude and duration exceed a predetermined value. Such a system is not taught by the cited references, and provides advantages over the system designs disclosed therein. These advantages are discussed in the section regarding claims 2-7, and reference is specifically made thereto. Accordingly, the rejection is overcome and Applicant respectfully requests withdrawal of the same.

Claims 8-11 also stand rejected as unpatentable over Chambers et al. (US (5,872,624 in view of Underwood, Jr. et al. (US 5,816,535). The Examiner argues that it would have been obvious "to include a second microprocessor in Chambers' system, because the second microprocessor may be used as a backup in the instance that the first microprocessor fails, as taught by Underwood. Applicant has amended claim 8 to recite the additional limitations:

> temperature control means for preventing temperature change of said laser diode beyond a predetermined temperature range;
>
> wherein said host microprocessor is programmed to set a set point temperature of the temperature control means.

Applicant's limitations added by the above amendment are described in the specification at page 3, lines 17-19, and page 4, lines 11-13, respectively. The proposed combination of Chambers and Underwood does not teach a design having the above limitations. In contrast to Applicant's claimed design, Chambers discloses temperature control wherein the temperature of the diode is purposefully <u>varied</u> to induce a change in output

wavelength of the laser (col. 3, lines 36-39). Moreover, there is no teaching in either of the cited references that would lead one to program a microprocessor to set a set-point temperature of temperature control means, for the purpose of minimizing temperature fluctuations in the laser. If anything, Chambers teaches away from such a modification. The rejections to claims 8-11 are therefore overcome, and Applicant respectfully requests withdrawal of the same.

WHEREFORE, all the submitted claims are believed to be in condition for allowance, which is respectfully solicited. If the Applicant may provide any further information, or assist the Examiner in the prosecution of the present application in any way, the Examiner is invited to contact the undersigned at (248) 364-2100.

Respectfully submitted,

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APPENDIX

Marked-Up Version of Claims Illustrating Changes

2. (PREVIOUSLY AMENDED) A method of controlling and/or monitoring a laser diode with a microprocessor having memory storage of data, the method comprising:

storing in said memory power-safety parameters of said laser diode with said microprocessor during operation of said laser diode, wherein [one of] said parameters include [is] laser pulse peak output power, and laser pulse duration;

continuously monitoring said laser output power;

continuously monitoring laser pulse duration; and

disabling operation of said laser diode whenever [said] one or more parameters are exceeded.

8. (AMENDED) A laser driver control system comprising:

a remote microprocessor;

a laser driver printed control board;

a host microprocessor on said printed control board;

at least one laser driver and a corresponding laser diode on said printed control board; and

a serial communication between said host microprocessor and said laser driver;

temperature control means for controlling a temperature of said laser diode within a predetermined temperature range;

wherein said host microprocessor is programmed to set a set point temperature of the temperature control means.

12. (PREVIOUSLY AMENDED) A method of controlling a laser diode comprising:

activating a control circuit that includes said laser diode at a current level less than the current threshold to activate said laser diode;

activating said laser diode by increasing the current in said control circuit above said threshold for a specified duration; and

reducing said current below said threshold to deactivate said laser diode;

operating temperature control means to maintain an output wavelength of said laser diode within a predetermined range during diode operation.

13. (PREVIOUSLY AMENDED) A laser driver control system comprising:

at least one laser diode, a circuit for sensing the current through said laser diode, comparator for continuously comparing said current to a predetermined value, and power supply switch for disabling said current to said laser diode if said current exceeds said value;

a power control circuit loop including the components of said sensing circuit, said comparator and power supply switch operably connected to a microprocessor to positively verify operation of said components, and means to disable said laser diode if operation of any of said components is not positively verified; and

a remote computer monitoring the pulse frequency and duration of said laser diode and means to disable said laser diode if predetermined pulse and duration values are exceeded; and

means to disable said laser diode if predetermined product values of pulse magnitude and pulse duration are exceeded.

Dated: March 31, 2003

CERTIFICATE OF MAILING

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service via Express Mail (EL 220549 503) in an envelope addressed to: Assistant Commissioner of Patents, Washington, D.C. 20231

By: [signature]